Integrating water and agricultural management

Integrating water and agricultural management: Collaborative governance for a complex policy problem

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INTERGRATING WATER AND AGRICULTURAL MANAGEMENT: COLLABORATIVE GOVERNANCE FOR A COMPLEX POLICY PROBLEM

Abstract

This paper examines governance requirements for integrating water and agricultural management (IWAM). The institutional arrangements for the agriculture and water sectors are complex and multi-dimensional, and integration cannot therefore be achieved through a simplistic 'additive' policy process. Effective integration requires the development of a new collaborative approach to governance that is designed to cope with scale dependencies and interactions, uncertainty and contested knowledge, and interdependency among diverse and unequal interests. When combined with interdisciplinary research, collaborative governance provides a viable normative model because of its emphasis on reciprocity, relationships, learning and creativity. Ultimately, such an approach could lead to the sorts of system adaptations and transformations that are required for IWAM.

Key words: institutional arrangements, governance, collaboration, inter-disciplinary research, adaptive environmental management.

1. Introduction

It is not difficult to appreciate why ideas of'integrated' and'joinedup' planning have become key motifs of emerging approaches to the sustainable management of water and agricultural systems. Decision makers with responsibility for this rapidly developing arena of crosssectoral policy quite reasonably seek a future in which system interdependencies will be recognised, priorities for management assigned, and responsibilities for action borne fairly. In England, for instance, the government department with responsibility for sustainable rural development recently published its strategy for water (Defra, 2008) setting out a vision that positions agricultural systems as central to the process of resolving competing issues of water supply and demand, and water quality and quantity by the year 2030. While priorities for action vary greatly according to political and material circumstances, parallel calls can be found elsewhere (Blanco, 2008; Conca, 2006; Faby et al., 2005; Lemos and Oliveira, 2005; Swatuk,

2005). Driven in part by the exigencies of an increasingly congested terrain of international agreements (such as the Convention on Biological Diversity) and laws (such as the pan-European Water Framework Directive), what holds this diversity together is the recognition that fragmented policy-making and implementation across the agricultural and water sectors continues to be a systematic and deeply institutionalised feature of natural resource management and, consequently, a major obstacle to the realisation of sustainable livelihoods and development.

Recent calls to address agriculture and water as linked policy and scientific agendas reflect, of course, the changing nature of priorities. For example, current interest in England for devising strategies that can mitigate the risks of diffuse pollution from agriculture to water is partly the consequence of a concerted effort during the 1970s and 1980s to intervene — primarily via regulation of privatised utilities — in problems of domestic, industrial and urban water management. That is to say, as significant gains in one arena of environmental protection have been made, 'blindspots' of regulation have also been revealed. Thus, the scientific and regulatory focus of action has changed as insight and public concern have evolved. At the same time, new problems with new complexities for the water and the agriculture sectors are emerging. The aforementioned strategy for water in England published by DEFRA is governed, in large part, by wider climate change agendas, and the need to build long-term resilience among urban and rural communities through the effective management of land–water interactions. Indeed, agriculture's role in influencing the water cycle is central to discussions of how climate change risks are managed and mitigated (Thorne et al., 2007).

In recent years, bodies of work have duly emerged seeking to explain how the co-dependencies of land, water and human wellbeing can be shaped according to the principles of sustainable development. From "integrated water management" (e.g. Furey and Lutyens, 2008) and "integrated catchment management" (e.g. Prato and Herath, 2007) to "integrated water resources management", (e.g. Saravanan et al., 2009) and "integrated environmental management" (e.g. Reagan, 2006), this variegated literature is important not only in the way it amplifies the types of natural and social scientific research required to understand these co-dependencies, but in signalling, quite clearly, the complex and changing institutional and political conditions of management. In

particular, one common line of reasoning in this work is to understand processes of natural resource management as being shaped, to an increasing extent, by the principles and practices of ‘governance’. This is a concept designed to point to the broadening and deepening of non-state activity in the policy process. It is closely related to wider normative debates about the need to foster more equitable, responsive and politically engaged forms of decision making. In this paper we critically inspect this idea and its implications for this special edition's specific concern with ‘integrating water and agricultural management’ (hitherto ‘IWAM’).

The paper begins by considering the origins of the governance agenda, outlining its key tenets and explaining how it is potentially taking science and policy into new conceptual and practical territory. We explain the discrepancies that surround this terrain, drawing attention to a body of work not only critiquing its empirical reality, but its underlying normative claims. Nonetheless, we argue that the regulatory thrust of the governance agenda — towards more collaborative and holistic approaches to working — is essentially well founded or at least is a step in the right direction. The paper then considers how these concerns might best be approached as an adaptive form of environmental management, one based on a commitment to dialogue, deliberation and negotiation among stakeholder groups with vested, often competing, assessments of policy priorities. The corollary to this, we suggest, is a series of interesting questions surrounding the role and nature of research, not least the matter of how to foster effective models of cross-disciplinary working that can create the kind of evidence base required to inform adaptive policy processes. We consequently argue that land and water governance and research have to be approached differently in the future if the process of integrating multi-sector and multi-scalar natural resource systems of management is to be realised in effective ways.

2. Institutional Challenges of IWAM

The institutional basis for developing integrated approaches to water and agricultural management is complex and multifaceted. Interpreted broadly, institutional structures and processes that underpin the formation and implementation of public policy

are political, legal, economic, social, and as well as administrative, in character (Mitchell, 1990; Saleth and Dinar, 2005). We suggest these structures and processes present a dynamic, and often contested, context in which to gauge prospects for IWAM. The situation in England and Wales illustrates this point well. Here, many of the companies providing public water supply and sewerage services are owned and operated by multi-national corporations, while the regulation of the industry involves a central government department (Department for Environment, Food and Rural Affairs), a nondepartmental agency (Environment Agency), an economic regulator (Office of Water Services) and an independent monitoring body (Drinking Water Inspectorate) (Watson et al., 2009). There are also complex arrangements for environmental protection that place these institutions within wider policy networks encompassing (among others) bodies with statutory responsibility for nature conservation (such as Natural England), designated authorities for protected landscapes (such as the National Park Authority), as well as regional and local government. In all of this, important cross-sectoral linkages between the water and agricultural sectors can be identified at the level of policy design, and indeed a multitude of partnership arrangements for spatial entities such as river basins, catchments and coastal zones are duly emerging as platforms for more integrated forms of land and water management. As elsewhere in the EU, an important case in point here would be the development of policy platforms that can respond to the emerging mandates of the Water Framework Directive. Even so, this potential for cross-sectorality belies a deeper institutional complexity. Debates about integrated approaches to agriculture and water systems are not, of course, conducted in isolation. Priorities for both sectors are implicated in a multi-scalar and contested political economy and bear the wider institutional influence of NGOs, professional associations, consumer groups, and perhaps most notably in the context of agriculture, trade organisations. This means that the institutional basis of shared programmes of action within, as much as between, the water and agricultural sectors are by no means assured.

For some, overcoming this complexity is less a matter of how to foster more co-ordinated institutional responses to water and agricultural management, but about fundamental changes in the way policy processes now take shape and assert influence. In particular, recent years have witnessed an emerging debate over whether we have entered

an era of ‘governance’ (Higgins and Lawrence, 2005; Hooper, 2005; Bakker, 2006; Warner, 2007; PahlWostl et al., 2008; Pahl-Wostl, 2009). This is an idea used to point to a change in the relationship between the state and civil society and the way in which responsibilities for the provision of environmental quality and other public goods are thought by some to have shifted since the 1980s (Pierre, 2000). Specifically it is suggested that the historically central role of the state and its bureaucracies in activities of planning, regulation, policy implementation, monitoring and evaluation has been recast under the ascent of more liberalised economic regimes. As a consequence, it is claimed that regulatory and institutional decision making increasingly involves actors operating beyond the boundaries of formal government as well as traditional state-based agencies and bureaucracies. Thus, it is argued that new spaces for policy-making have emerged, which are occupied by a diverse range of self-organizing actor networks, public–private partnerships, and other multi-party arrangements. In an era of governance, then, distinctions and boundaries that previously defined state-market-civil society relations are thought to have increasingly blurred (Bevir, 2009).

For those interested in natural resources and the environment, the claim that we have entered an era of‘governance’ brings with it a new set of challenges. As Tropp (2007) argues in the context of water management, governance based management relies on developing more ‘sociocratic’ forms of knowledge and capacity development; putting the emphasis on the management of people and processes, organisational diversity and knowledge sharing. Yet the extent to which such a transformation is possible and the degree to which governments are ready and willing to share power with non-state actors remains unclear it is the object of political contestation. While in principle government departments and public authorities are now often required to interact on more equal terms with other social ‘players’ and alongside a host of other powerful non-state entities (Stoker, 1998), the role and the influence of non-state actors in decision-making processes remains uneven and highly contested.

In purely practical terms, the orchestration of multiple actors and interests and the marshalling of collective action are difficult tasks themselves. Working effectively in an era of governance means challenging entrenched attitudes and practices, overcoming organisational resistance to change, and mobilising individuals to engage with seemingly

intractable, cross-sectoral, environmental problems. Perhaps more critically, Petersen et al. (2009) argue that, while a governance approach favours the collective resolution of problems, it is often the state that continues to take ultimate responsibility, particularly where blame or liability cannot be established due to uncertainty, poor data and/or lack of evidence. As a result, there is a risk that, when superficially adopted, a governance approach simply serves to renew and reemphasize state power (and the influence of the stronger groups of interest) in environmental politics, rather than fundamentally changing the policy formulation or implementation process. Similar arguments have been made elsewhere. Writing in the context of water management and the provision of water services, Bakker (2003) explains that governance based decision making can amount to a process of re-regulation in which tacit state control of the allocation and management of resources remains. A related observation has been made by Ioris (2009), who demonstrates how the main policy instruments of water governance are often appropriated by the stronger stakeholder groups and, in circumstances of a weak institutional context, result in the maintenance of long-lasting management problems and associated asymmetrical power relations. As such, collective action to integrate water and agriculture within a governance framework cannot be taken as a given or neutral procedure. Indeed, for some, governance remains a deeply problematic concept which fails to take adequate account of the politics and power relationships that exist within resource management regimes (Castro, 2007; Mollinga, 2008).

If there is a tendency to overlook the fact that interventions in water and land systems by different categories of stakeholders (characterised by unequal political opportunities and varied access to resources) tend to generate costs, benefits and risks in uneven ways (Molle, 2007) it is also the case that the challenges of dealing with multiple actors with competing interests and values are now exacerbated by problems of scale and spatial ‘fit’. It is notable here that the catchment area or river basin is often represented as the most effective operational scale for managing land–water dynamics (c.f. Oliver et al., 2009), but in institutional terms such prescriptions are often problematic (Moss, 2003) Experience in integrated catchment management has shown, for instance, that the effectiveness of catchment-scale policy interventions is frequently limited by factors such as multiple over-lapping agency and organisational jurisdictions, fragmented and poorly

co-ordinated administrative structures and processes, differences in power, unclear lines of responsibility and authority, and slow and unresponsive decision making. It is in this vein that social scientists have argued that catchments are more than just a landscape carved by the flow of water from headwaters to the mouth, but an unstable, 'permeable' and evolving socio-ecological system (Molle, 2007).

To the extent that catchment scale planning continues to be positioned as the site where integrated governance and resource management will be realised, it remains clear that at least some of these systemic failings can only be addressed by reconciling catchment politics with the higher and lower scales of governance that produce them. That is to say, the process of joining up the governance of agriculture and water management depends as much on enhancing the vertical linkages among decision making nodes at different spatial and institutional scales, as it does on fostering closer horizontal links between the two sectors. In this sense, the drivers of change which shape these systems are effectively unbounded and operate outside and inside of the bio-physical parameters of catchment systems. This seems certainly the case when we think of water management in the context of agricultural change. The local practices of farmers are shaped by a wider political economy of agriculture which may not be necessarily in step with the goals of sustainable water management. In Europe, processes of trade liberalization and CAP reform, for instance, are major drivers of land use change (Potter and Tilzey, 2007), yet such factors are rarely, if ever, acknowledged or fully addressed within water policy. Furthermore, the water management community has a tendency to portray agriculture simply as a cause of both water quality and quantity problems whilst failing to acknowledge its vital role in food production and maintaining rural livelihoods.

To summarize, institutional arrangements for both water and agriculture are complex and multi-dimensional encompassing networks of 'loosely-coupled' state and non-state actors. For some these arrangements characterise a transition towards more governance based approaches to natural resource management, though empirical reality of this transition is by no means settled. As we have shown the idea of governance is inevitably a highly contested and politicised process through which resources are allocated and benefits and costs are distributed. In such circumstances IWAM cannot be treated as a purely technical or scientific matter. It requires the development of a process

that is capable of making trade-offs among competing objectives and reconciling different values and beliefs regarding the use and management of land and water. This presents considerable challenges for many IWAM related agendas today, not least in addressing the institutional ramifications of managing water and agricultural systems across spatial scales. From a scientific perspective, the catchment, watershed or river basin may appear to be the most logical scale for the integration of water management and agriculture (Newson, 2008). Nevertheless, many of the market and institutional processes that drive and regulate both water management and agriculture operate at entirely different scales. As such, IWAM requires an approach to governance that is capable of working both inside and outside the frame of catchment management and is able to deal with the dynamic relationships between water and agricultural systems. The question of how these challenges might be addressed within a governance framework for IWAM is examined in the following section.

3. Towards alternative models of governance

One of the central social science challenges to emerge from these complexities is the identification of approaches to governance which can satisfactorily cope with unbounded system interconnections. This would be relatively easy if it were simply a matter of constraining uncertainty and complexity by cumulatively investing in more sophisticated scientific research. However, such an approach overlooks important philosophical arguments about the limits of knowledge in a complex and rapidly changing world. As the scale of the unit of analysis is expanded from a single farm up to an entire catchment area and beyond, an increasing number of systems, interactions, feedbacks and nonlinearities are brought in to play. This results in a step-change in the nature of the uncertainty that has to be confronted, moving from‘risk’where prediction is possible, through to ‘ignorance’ and even situations of ‘indeterminacy’, where understandings of system boundaries and interactions are defied because they are in constant flux (Wynne, 1992). In the absence of certainty, it is inevitable that issues such as managing the effects of agriculture on nutrient pollution or flood risk or agricultural demand for water tend to be highly controversial. Indeed, recognising the boundaries of what it is possible to know in a limited period of time and reaching consensus when data and evidence are

lacking are indicative of the fundamental challenges associated with IWAM. It is clear that governance models with the capacity to cope with these sorts of 'messy' or 'turbulent' conditions must be created (Trist, 1980). Conventional models that emphasize rational-comprehensive and technocratic styles of policymaking dominated by government bureaucracies are unlikely to be a good match in these circumstances.

In recent years, more collaborative forms of governance have started to emerge in a variety of different spatial and environmental contexts in response to the perceived deficiencies of technical knowledge and, we contend, have great potential for dealing with the challenges of IWAM (Wondolleck and Yafee, 2000; Armitage et al., 2008). Drawing on theoretical arguments concerning communicative rationality, discourse and policy dialogue (Habermas, 1981; Innes and Booher, 1999), collaboration is posited as a highly interactive and adaptive process that is capable of transforming social relations by creating new knowledge networks among interdependent actors and interests. This can include interests with little or no prior experience of each other because they operate in socially and organisationally separate domains at entirely different spatial scales, or those who have been historically engaged in competition or conflict over underlying institutional, commercial or cultural priorities. In this vein, Dengler (2007) demonstrates how different organisations and groups, whist invested with different degrees of power, can work together to achieve agreed policy outcomes, and advocates a regime of governance based on sharing expertise between complementary organisations, so called 'knowledge-based' governance.

Conventional styles of policy-making have certainly involved interactions across institutional and social boundaries, often in the form of co-operative agreements and efforts to co-ordinate policies and practices. However, these are relatively short-term arrangements designed to allow each party to pursue separate goals and objectives under stable policy conditions. In these circumstances government agencies often remain in control of the decision-making process with limited accountability. Collaborative governance, in contrast, involves a more sophisticated, emergent and enduring form of interaction in which two or more groups pool understanding and/or tangible resources to address a set of problems which neither could solve alone (after Gray, 1985). It is a

process in which organizations and groups are required to re-examine basic assumptions, beliefs, attitudes and values through iterative cycles of knowledge exchange, dialogue, deliberation and negotiation. It is suggested that through this process joint understandings and commitments for action begin to emerge (Watson, 2007).

In practical terms collaboration involves a number of phases (Fig. 1), as well as opportunities and constraints which are shape by prevailing economic, social, political and environmental conditions (Watson, 2004). Often, collaboration is initiated as a result of several factors, such as a perceived environmental threat or crisis, a new legal mandate, or the availability of financial incentives. When an initial commitment to collaboration has been made, a 'problem-setting' phase occurs in which groups with legitimate stakes are identified and the nature of the joint problem or issue they face is articulated (Gray, 1989; McCann, 1993). As a result stakeholders begin to appreciate their interdependence and the need to act together. In the subsequent 'direction-setting' phase, participating organisations focus on desirable future conditions as well as the underlying values, beliefs and principles that will guide them towards their joint ambitions and aspirations. This tends to be followed by a 'structuring phase' in which specific goals and objectives are established, programmes of activity are designed, and roles and responsibilities are assigned to the various participating organisations and groups. Although some commentators regard this to be the end of the process, others have argued that collaboration should generate outputs, such as policies and programmes (Selin and Chavez, 1995), which must be implemented in order for measurable outcomes to be realised.

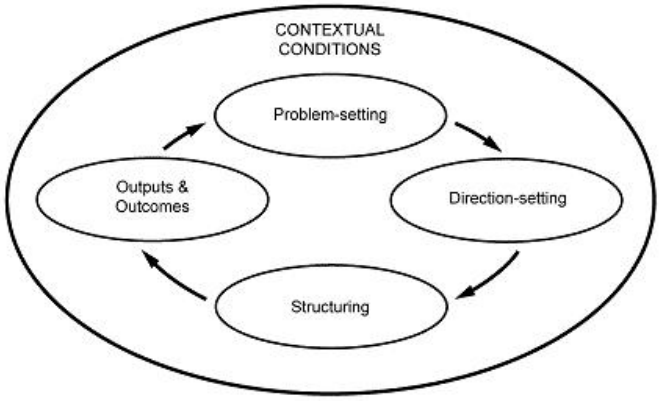

Figure 1. Conceptual framework for collaborate governance.

Whilst it is convenient to conceptualize collaboration as a well-defined process, in practice some of the phases may occur simultaneously and several cycles may be required over time before satisfactory results are achieved. In other cases, changes in knowledge or circumstances may require the participants to return to one or more of the earlier phases of activity in order to re-define problems, objectives or working arrangements.

According to Innes and Booher (2003), this sort of collaborative approach is not just a method for solving complex problems in the existing policy system, but crucially is a way of establishing new networks through which capabilities can be developed and sustained. Effective collaboration can be identified from four immediate or first-order results: reciprocity; relationships; learning; and creativity. Collaborative dialogue can lead to the establishment of reciprocal relationships among the participants as they begin to appreciate their interdependence. A reciprocal agreement might involve compromises among the participants but it can also lead to a situation where one group is able to take action at little or no extra cost which may have benefits for others. Such situations arise when there is a strong sense of purpose and a commitment to a common vision of a future that is more desirable than present-day conditions. It is important to realise that reciprocity is not a predetermined or straightforward attribute of the interplay among stakeholders, but is a constructed quality that helps groups to do joint work and to build trust. That is why successful collaboration also builds relationships and social capital based on mutual understanding and respect. It is precisely these kinds of enduring human and inter-organisational resources that enables collaborative governance to cope with uncertainty, changing conditions, contested knowledge and conflict; conditions which are closely associated with the objectives of the IWAM agenda. A further result of collaboration is collective learning. Participants not only learn about the problem at hand and how scientists and lay groups understand it, but they also typically learn about the values and norms of the other interests and actors involved. More fundamentally, engagement in collaboration can eventually lead to deep ‘double-loop learning’ whereby the values, beliefs and norms of a participating group are transformed (Argyris and Schön, 1978, Pahl-Wostl, 2002 and Pahl-Wostl, 2009). Problem-framings, aims, objectives and strategies may be adjusted on the basis of the shared understanding that

emerges from collaboration. Finally, one of the greatest virtues of collaboration is that it encourages out-of-the-box thinking and creativity. Potential strategies and solutions which might otherwise be dismissed as irrelevant or poorly informed are likely to receive more considered and careful attention in an environment where alternative views and perspectives are valued and respected. Ultimately, effective collaboration can lead to system adaptations because of the shared identities, meanings, heuristic principles and innovations that it creates. It is precisely these kinds of system adaptations that are needed in order to bring about the integration of water and agriculture.

It should be noted that this analysis is not designed to imply that collaboration is unproblematic. Indeed, one of the main challenges of this approach to governance and problem-solving is to maintain trust and commitment to shared long-term goals when obstacles are encountered and when evidence of progress is only weak. Potential benefits as well as challenges and risks associated with collaborative approaches to the governance of land and water are summarized in Table 1.

Table 1- Potential benefits, challenges and risks of collaboration.

Benefits	**Challenges and risks**
Improved personal, social and inter-organisational relations.	Increased transaction costs due to the number of actors involved and the added complexity of decision making.
Access to alternative sources and forms of scientific and lay knowledge.	'Capture' or diversion of the process due to asymmetrical power relations among the participants.
Deep learning leading to the exploration of underlying values, assumptions, attitudes and expectations.	Potential 'implementation gaps' arising from difficulties in translating agreed plans into policies, projects and actions.
Re-framing of complex issues and questions, leading to enhanced problem-solving capacity.	Failure to broker agreement in the face of uncertainty, limited data or contested knowledge.
Legitimization of decisions through consensual decision making.	Maintaining trust among organisations with different cultures, norms and practices.

Commitment to long-term goals and future visions.	Ensuring the benefits and costs of collaboration are fairly distributed among the participants.
Leverage of additional financial, technical, administrative and political resources.	Maintaining commitment to long-term goals when evidence of progress may be limited.
Re-allocation of roles and responsibilities according to organisational capacities and skills.	

Perhaps most significantly, the obstacles of making a full transition from old systems of governing and policy-making to a new ethic and regime of collaborative governance should not be underestimated. Other models of policymaking, which rely more on political influence, technocratic tools and bureaucratic structures are deeply embedded in the institutional systems of agriculture and water and will not easily be removed or reformed. At the individual level, personnel involved in either sector may inadvertently preserve values and practices that reflect centralised, unresponsive modes of governance when trying to achieve collaboration. What this implies is that the future development of IWAM governance is likely to be hesitant and contested because the process of implementation brings together different perspectives, values, norms and customs. Much will rest on the level of political and scientific support given to the process of integrating water and agriculture and the ability of government ministers and civil servants as well as non-governmental stakeholders to push through institutional reforms aimed at improving genuine collaboration.

Ultimately, a viable approach to governance for agriculture and water systems must be capable of integrating multiple voices and reconciling competing interests. Dealing with complexity and uncertainty requires innovative strategies to the relations among social groups and between society and the state apparatus which can foster constructive and enduring collaboration. This means that governance is not just about changing the format of policy-making or management activities, but a profound shift in

terms of commitment to working together to understand, and constructively resolve shared problems. Collaboration creates some of the conditions upon which legitimate actions depend even in the face of uncertainty and political and socio-economic differences among groups or spatial areas. It is the most appropriate model for the achieving this change because of its commitment to dialogue, deliberation and negotiation. By enabling reciprocal agreements, establishing enduring institutional and social relationships, promoting learning and encouraging creativity, collaborative governance has the potential to produce the kinds of transformations which IWAM is seeking to achieve.

4. Integrating the 'social' and the 'natural' in land-water research

In the same way that integration challenges current thinking about governance and policy-making, it raises equally fundamental questions about how academic research should be organised and conducted. As clients of this new policy agenda, single-discipline researchers with historically little reason (or perhaps inclination) to share the same intellectual space must now navigate a stable pathway through a fundamental and seemingly intractable set of issues regarding how scientists — as a diverse community of social and natural science researchers — describe and construct the realities of water and land management, acquire and marshal knowledge for the purposes of closer integration, and judge the efficacy of our interventions. These are just some of the questions that characterise the problem of creating and operating within integrated research 'platforms' (Warner, 2007). For some, this might imply a compromise and dilution of standard disciplinary pathways to knowledge and understanding; the idea that integrated thinking lies at the 'shallow-end' of water research. For others, progress towards the application of these policy goals is not only producing novel theoretical constructs in the arena of land–water research but driving the formation of new study areas that do not respect neat disciplinary boundaries (see Lane et al., 2006). At the same time, the outputs of joined-up research on agri-water systems from research must reflect the needs of policy and practice if there is to be any real prospect of making new knowledge relevant and 'useful'.

Given the simultaneously human and non-human complexion of land–water systems it is perhaps not surprising that collaboration across the social and the natural sciences is regarded as a necessary, and underpinning, facet of integrated land–water policy. One of the common presumptions behind this view is that we can create holistic understandings of land–water systems rather like fitting together a jigsaw puzzle, with cognate specialisms and expertise adding up to a complete picture. In essence, the logic is that the natural and social sciences, by their very nature, are concerned with different parts of a connected reality: the natural sciences accounting for the environmental manifestations of human and non-human processes; the social sciences for the economic, social, political and cultural relations that condition and give rise to them. In other words, the rationale behind this 'additive' world-view rests on the notion that the social and natural sciences are compatible with each other because they prioritise different thematic areas in the study of land–water interactions. By working collectively, it is argued, social and natural science researchers are therefore able to make up for disciplinary deficiencies and forge innovative approaches to complex questions.

Holistic scientific working involving the meshing together of different types of preoccupations and expertise is a fundamentally attractive idea, yet two key challenges emerge with it. The first of these challenges concerns the need to reconcile the prevalent divergence between natural and social science research. That is to say, an important precondition of joined-up approaches *between* natural and social science is to foster coherent conceptual and methodological narratives *within* them. In the natural sciences, this problem has been addressed by Haygarth et al. (2005), who, specifically in the case of phosphorus research, draw attention to the different cognate specialisms underpinning this field of inquiry and highlight the kind of challenges (and possibilities) arising for the research community when seeking to create collaborative and mutually reinforcing agendas in the context of contrasting methodological logics. An equivalent analysis of the social sciences shows that economics, political science, geography, psychology, anthropology, sociology and planning, to name but a few, all have something of value to offer the IWAM debate. While cross-fertilisation of ideas (and careers) amongst these fields make it difficult to appreciate how exactly each has added to understanding of water management and agriculture, it is certainty the case that this community has

produced a rich mix of research priorities, and fostered varied pathways to an understanding of the relations between society and nature (Haberl et al., 2006, Waterton et al., 2006, Dixon and Sharp, 2007, Giller et al., 2008 and Jansen, 2009).

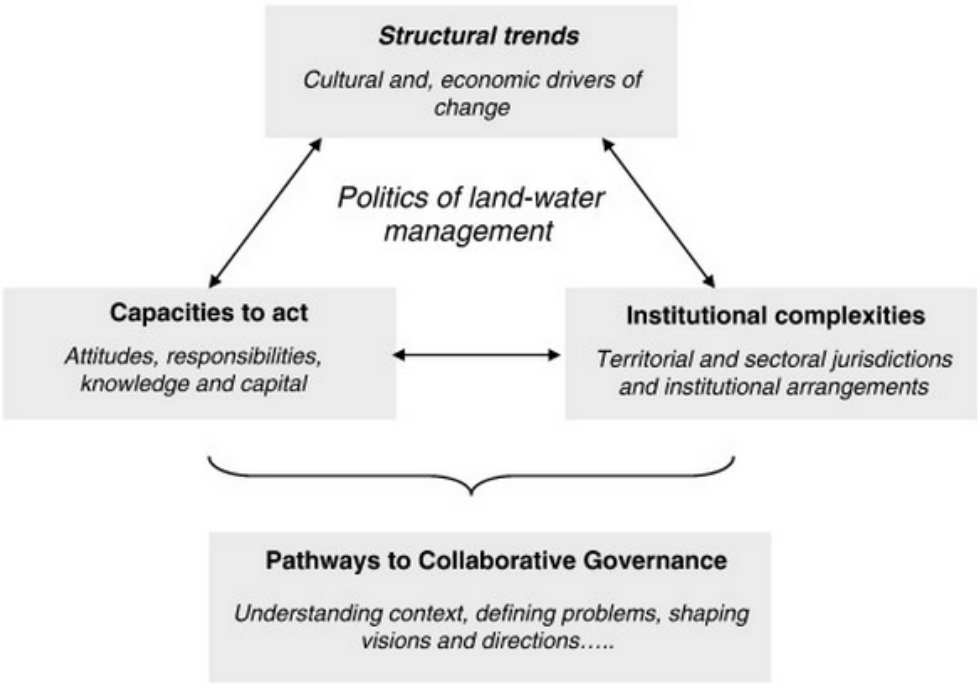

Figure 2. The thematic scope of social sciences research in IWAM..

Given this, some of the principal cross-disciplinary preoccupations of social science approaches are depicted in Fig. 2, which highlights three arenas of inquiry around which it seeks to understand the politics of land–water management: structural trends, capacities to act and institutional complexity. Each of these cognate areas of inquiry provides the analytical insights necessary to promote effective pathways to collaborative governance. Thus, sites of inquiry shift from studies of 'capacity' in which the concern is to unpack how attitudes, responsibilities, knowledge and capital come to shape the behaviour of individuals and groups, through to an account of the territorial and sectoral jurisdictions that influence frameworks of interventions across multiple scales, and finally into the analysis of 'structural trends' — cultural and economic — that dictate wider terms in which inclinations and capacities to act take shape. What this implies is that

IWAM related research must seek to understand how these domains interact to produce barriers and opportunities for effective action, the first and necessary step in the collaborative process.

The second key challenge concerns the development of approaches to joint working that have the potential to *transform*, rather than simply *reaffirm*, segmented ways of researching land–water problems. In its most reductive form, holistic thinking is conflated with the idea of *multidisclipinarity*: in essence the provision of a sequence of distinct, neatly bounded, disciplinary perspectives around a given research problem (Tress and Tress, 2001). According to this logic, communities of research find common cause in a particular aspect of land–water systems (diffuse pollution, flood risk, or drought, for example), but since priorities are shaped by different kinds of issue, standard disciplinary pathways to knowledge remain largely intact. In effect, the research problem is itself divided up according to the particular theoretical, methodological and empirical perspectives favoured by the participating disciplines. It is almost inevitable that such an approach will lead to answers that are specific to the different elements under study and that understanding the research problem as a whole can remain elusive. As such, the idea of a holistic, trans-disciplinary or even post-disciplinary approach to land–water systems remains at best a distant aspiration of the research process, and at worse a cover for a 'business as usual' discipline-bound approach to problem framing and investigation. Despite a stronger emphasis on the need for interdisciplinary research agendas, and the incorporation of non academic expertise it is still the case that universities and research councils in general continue to assess the quality of academic work in terms of relevance to single disciplines. This is a major disincentive for the kind of innovation and collaborative working that is required to develop and deliver integrated strategies for water and agriculture.

One unfortunate consequence for IWAM of simplistic *inter-disciplinary* thinking is that it tends to reinforce certain caricatures of what social and natural sciences are perceived to do, and leads to deeply problematic and unreflexive views of the power we should (or should not) then invest in social and natural science judgment. In a disciplinary world, it is not unusual, for instance, for social scientists to be derogatively consigned to a rather nebulous world of conjecture and interpretation; the implication being that, not

only do they have little meaningful affect on material processes and outcomes, but engage in a kind of obfuscatory relativism that serves to stall expedient forms of action. Accordingly, abstracted from the messy social relations and politics of the human world, natural sciences can duly carry on with the business of 'evidence gathering', revealing the deeper 'objective' truths behind appropriate policy action.

In contrast, ideas of *interdisciplinarity* and *transdisciplinary* offer more expansive and pro-active interpretations of holistic working. In the former case, models of working proceed and carry with them an underlying aspiration for synthesis (Fish et al., 2008). Problems are defined collaboratively from the outset of research while methodological frameworks are designed to synthesise findings at strategic points in the research process. Transdisciplinarity working, in turn, implies progression to a vision of holistic research involving, as Harvey (2006, p.332) has put it in the context rural economy and land use, "unification of the involved disciplines at the paradigmatic (metaphysical) level". In these circumstances, common vocabularies of problem framing may begin to emerge among ostensibly different kinds of land–water researchers, methodological pathways to knowledge associated with one disciplinary area begin to find expression and application in others — often transforming them in the process — while underlying assumptions concerning the basis of disciplinary authority begin to dissipate. Importantly, a common characteristic of transdisciplinarity is its tendency to collapse neat distinctions between scholarly and non-scholarly communities of expertise, a characteristic which resonates well with the ambitions, logic and ethic of IWAM.

In the same way that IWAM governance cannot be treated as an additive processes in which two policy arenas are simply joined together, IWAM research demands a more sophisticated, collaborative and beyond-disciplinary approach. At the present time, most IWAM research appears to be characterised by either single discipline or multi-disciplinary work within the natural or social sciences. Research which seeks to transcend the conventional natural/social divide in land and water research is a very recent development which requires a significant 'up-front' investment of time and trust in order to develop common definitions, conceptual models, methods and working languages (Bracken and Oughton, 2006). However, scale dependencies, system interactions and adaptations, risk and uncertainty are all concepts which are recognized

and have currency in the natural and social sciences and therefore have great potential as the basis of a common language for trans-disciplinary IWAM research.

4. Conclusions- moving IWAM Forward

IWAM has emerged as a new policy agenda from a variety of different debates about rural resource management, including diffuse and point-source pollution, flood risk, water conservation, drought management, and sustainable farming and food systems. Whilst a broad range of policy fields and research disciplines related to land and water have switched-on to the idea of joined-up ways of working, the underpinning concept of *integration* is used in a variety of ways and has not received sufficient careful consideration. Indeed, much of the debate about IWAM to date has been concerned with the scientific, technical and economic dimensions of land and water. While such debates are necessary for the development of effective policy tools and instruments, other fundamental and equally important questions related to the integration of policymaking for agriculture and water, and the role of science in that process, demand much closer research attention.

IWAM is not just about the connection of two very different policy areas (agriculture and water) at a single (catchment) scale. Both agriculture and water management are complex multi-layered socio-biophysical systems, and neither are neatly delineated or organized to fit hydrologic boundaries defined solely by river catchment areas or river basins. As a consequence, a superficial 'additive' approach to integration is not viable for IWAM because it fails to take adequate account of the complex, multi-dimensional and uncertain nature of the systems which policy makers and researchers are attempting to merge. To use a simply analogy, the integration of agriculture and water management is not like a jig-saw puzzle with a relatively small number of large pieces which simply have to be put together in the right order to create a complete picture. Rather, it is more like a puzzle in which the sizes and shapes of a large number of pieces are constantly changing, producing different patterns and configurations over time. Clearly, this sort of task requires a much more sophisticated and creative approach to both policy and research.

In a policy environment characterised by complex, evolving systems and interactions, pervasive uncertainty and contested knowledge claims, the difficult task of jointly managing water and agriculture cannot be achieved by government departments or public agencies acting in isolation, no matter how large or powerful they might be. Clearly, such organisations have legal responsibilities for land and water and are likely to play key roles, but the IWAM policy process itself must be based on a new system of multi-party and multi-level governance that not only operates within catchments but is also linked to higher and lower levels of governance and private decision-making. Collaborative governance, we contend, provides the kind of response repertoire that is required to begin coping more effectively with complexity and uncertainty, to re-align agriculture and water in the context of rural space, and to achieve the ambitious policy goals of IWAM. One of the implications is that those who are involved in the development and application of IWAM policy need a clear understanding of the different phases in a collaborative process, the kinds of organisational, management and research skills that it demands, the potential pitfalls and recovery strategies, and the kinds of outputs which can be expected to lead to positive outcomes in the long-term.

The IWAM agenda also has major implications for the ways in which research on agriculture and water is practiced. Future IWAM research needs to be trans-disciplinary and synthetic rather than simply multi-disciplinary and additive if it is to yield worthwhile knowledge regarding systemic interactions across multiple scales. As such, a common language is required to enable researchers from very different disciplinary backgrounds in the natural and social sciences to understand each other in order to develop shared problem definitions and make use of combined methodologies. Concepts such as ‘complexity’, ‘interdependence’ and ‘uncertainty’ could provide very useful starting points. Such terms might have different meanings to different research communities, but nevertheless provide some common ground for the development of a dialogue about how IWAM can be understood and further developed.

One of the potential dangers in advocating both collaborative governance and trans-disciplinary research for IWAM is that the two activities become distanced from one another when in fact what is needed is an arrangement whereby policy and research

are mutually re-enforcing. Once again, notions such as ‘complexity’ and ‘uncertainty’ are readily recognized by both the policy and research communities and could provide the necessary bridges between them. In particular, approaches such as Adaptive Environmental Management (AEM) have been specifically designed to combine policy-making and research in highly complex, dynamic and uncertain environments (Holling, 1978 and McLain and Lee, 1996). The underlying principle of AEM is that policies inevitably have to be designed on the basis of incomplete scientific understanding, and therefore should be treated as trial-and-error experiments which are adapted over time on the basis of feedback from scientific monitoring and evaluation. In effect, AEM brings together policy makers and researchers in a collaborative governance environment where complexity and uncertainty are openly acknowledged and addressed. Given the nature of the scientific and policy challenges associated with the integration of agriculture and water management, it is precisely this sort of pro-active, experimental and collaborative approach that needs to be developed for the future.

At the present time, IWAM represents a long-term goal or aspiration that has yet to be fully translated into an operational strategy for dealing with water and agriculture in a holistic or inter-connected fashion. Any future strategy must be capable of maintaining food production systems without compromising the long-term viability of water and ecological systems. In addressing agriculture and water in a combined way, IWAM must include a range of stakeholders who are unlikely to have interacted closely with each other in the past. As such, IWAM requires particular effort in developing mutual understanding, negotiation and cooperation so that political, organisational and disciplinary differences and conflicting interests can be overcome. Ultimately, success will depend on the development of transparent and legitimate channels of dialogue and collaboration that connect the local, catchment, national and international scales of governance and research on agriculture and water.

References

Argyris C, Schön DA. Organizational learning: a theory of action perspective. Reading: Addison-Wesley; 1978. 339 pp.

Armitage D, Marschke M, Plummer R. Adaptive co-management and the paradox of learning. Glob Environ Change 2008;18(1):86–98.

Bakker K. An uncooperative commodity: privatizing water in England and Wales. Oxford: Oxford University Press; 2003. 224 pp.

Bakker K, editor. Eau Canada: the future of Canada's water. Vancouver: UBC Press; 2006. 417 pp.

Bevir M. Key concepts in governance. London: Sage; 2009. 218 pp.

Blanco J. Integrated water resource management in Colombia: paralysis by analysis? Int J Water Resour Dev 2008;24(1):91-101.

Bracken LJ, Oughton E. What do you mean? The importance of language in developing interdisciplinary research. Trans Inst Br Geogr 2006;31:371–82.

Castro JE. Governance in the twentieth-first century. Ambient Soc 2007;10:97-118.

Conca K. Governing water: contentions transnational politics and global institution building. MIT Press, Cambridge, Mass. and London, MIT Press, 2006, 484 pp.

Dengler M. Spaces of power for action: governance of the everglades restudy process (1992–2000). Polit Geogr 2007;26:423–54.

Department for Environment, Food and Rural Affairs. Future water: the government's water strategy for England. Defra Publications; 2008. Accessible on line at http:// www.defra.gov.uk/corporate/publications/pubcat/pol.htm.

Dixon J, Sharp L. Collaborative research in sustainable water management: issues of interdisciplinarity. Interdiscip Sci Rev 2007;32:221–32.

Faby J, Neveu G, Jacquin N. Towards a European-wide exchange network for improving dissemination of integrated water resources management research outcomes. Environ Sci Policy 2005;8:307–19.

Fish R, Seymour S, Watkins C, Steven M. Agendas for transdisciplinarity. Sustainable farmland management: transdisciplinary approaches. Wallingford: CABI; 2008. p. 249–52.

Furey SG, Lutyens BC. Developing an integrated water management strategy to overcome conflicts between urban growth, water infrastructure and environmental quality: a case study from Ashford, Kent. Water Environ J 2008;22:42–53.

Giller KE, Leeuwis C, Andersson JA, Wim A, Brouwer A, Frost P, et al. Competing claims on natural resources: what role for science? Ecol Soc 2008;13 Article 34.

Gray B. Conditions facilitating inter-organizational collaboration. Hum Relat 1985;38: 911–36.

Gray B. Collaborating: finding common ground for multiparty problems. San Francisco: Jossey-Bass; 1989. 358 pp.

Haberl H, Winiwarter V, Andersson K, Ayres RU, Boone C, Castillo A, et al. From LTER to LTSER: conceptualizing the socioeconomic dimension of long-term socioecological research. Ecol Soc 2006;11(2):13.

Habermas J. The theory of communicative action: reason and the rationalisation of society. Boston: Beacon Press; 1981.

Harvey DR. RELU special issue: editorial reflections. J Agric Econ 2006;56(2):329–36.

Haygarth PM, Condron LM, Heathwaite AL, Turner BL, Harris GP. The phosphorus transfer continuum: linking source to impact with an interdisciplinary and multiscaled approach. Sci Total Environ 2005;344(1–3):5-14.

Higgins V, Lawrence G, editors. Agricultural governance: globalization and the new politics of regulation. London: Routledge; 2005. 208 pp.

Holling CS. Adaptive environmental assessment and management. Chichester: Wiley; 1978. 363 pp.

Hooper B. Integrated river basin governance: learning from international experience. London: IWA Publishing; 2005. 306 pp.

Innes JE, Booher DE. Consensus building and complex adaptive systems. Am Plan Assoc J 1999;65:412–23.

Innes JE, Booher DE. Collaborative policymaking: governance through dialogue. In: Hajer MA, Wagenaar H, editors. Deliberative policy analysis: understanding governance in the network society. Cambridge: Cambridge University Press; 2003. p. 33–65.

Ioris AAR. Water reforms in Brazil: opportunities and constraints. J Environ Plan Manag 2009;52:813–32.

Jansen K. Implicit sociology, interdisciplinarity and systems theories in agricultural science. Sociol Rural 2009;49:172–88.

Lane SN, Brookes CJ, Heathwaite AL, Reaney SM. Surveillant science: challenges for the management of rural environments emerging from the new generation diffuse pollution models. J Agric Econ 2006;57:239–57.

Lemos MC, Oliveira JLF. Water reform across the state/society divide: the case of Ceará, Brazil. Int J Water Resour Dev 2005;21:133–47.

McCann J. Design guidelines for social problem-solving interventions. J Appl Behav Sci 1993;19:177–92.

McLain RJ, Lee RG. Adaptive management: promises and pitfalls. Environ Manage 1996;20:437–48.

Mitchell B. Integrated water management: international experiences and perspectives. London: Belhaven; 1990. p. 225.

Molle F. Scales and power in river basin management: the Chao Phraya River in Thailand. Geogr J 2007;173:358–73.

Mollinga PP. Water, politics and development: framing a political sociology of water resources management. Water Altern 2008;1:7-23.

Moss T. Solving problems of 'fit' at the expense of problems of 'interplay'? The spatial reorganisation of water management following the EU Water Framework Directive. In: Briet H, Engles E, Moss T, Troja M, editors. How institutions change: perspectives on social learning in global and local environmental concerns. Opladen: Leske and Budrich; 2003. p. 85-121.

Newson MD. Land, water and development: sustainable and adaptive management of rivers. London: Routledge; 2008. 480 pp.

Oliver DM, Heathwaite LH, Fish RD, Chadwick DR, Hodgson CJ, Winter M, et al. Scale appropriate modelling of diffuse microbial pollution from agriculture. Prog Phys Geogr 2009;33:358–77.

Pahl-Wostl C. Towards sustainability in the water sector — the importance of human actors and processes of social learning. Aquat Sci 2002;64:394–411.

Pahl-Wostl C. A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. Glob Environ Change 2009;19: 354–65.

Pahl-Wostl C, Kabat P, Moltgen J, editors. Adaptive and integrated water management. Berlin: Springer-Verlag; 2008. 440 pp.

Petersen T, Klauer B, Manstetten R. The environment as a challenge for governmental responsibility: the case of the EuropeanWater Framework Directive. Ecol Econ 2009;68: 2058–65.

Potter C, Tilzey M. Agricultural multifunctionality, environmental sustainability and the WTO. Geoforum 2007;3:1290–303.

Pierre J. Debating governance: authority, steering and democracy. Oxford: Oxford University Press; 2000. 251 pp.

Prato T, Herath G. Multiple-criteria decision analysis for integrated catchment management. Ecol Econ 2007;63:627–32.

Reagan DP. An ecological basis for integrated environmental management. Hum Ecol Risk Assess 2006;12:819–33.

Saleth RM, Dinar A.Water institutional reforms: theory and practice. Water Policy 2005;7:1-19.

Saravanan VS, McDonald GT, Mollinga PP. Critical review of Integrated Water Resources Management: moving beyond polarised discourse. Nat Resour Forum 2009;33: 76–86.

Selin S, Chavez D. Developing a collaborative model for environmental planning and management. Environ Manage 1995;19:189–95.

Stoker G. Governance as theory: five propositions. Int Soc Sci J 1998;155:17–28.

Swatuk LA. Political challenges to implementing IWRM in Southern Africa. Phys Chem Earth 2005;30:872–80.

Thorne CR, Evans EP, Penning-Rowsell E. Future flooding and coastal erosion risks. London: Thomas Telford; 2007.

Tress B, Tress G. Capitalising on multiplicity: a transdisciplinary systems approach to landscape research. Landsc Urban Plan 2001;157:143–57.

Trist E. The environment and system-response capability. Futures 1980;12:113–27.

Tropp H. Water governance: trends and needs for new capacity development. Water Policy 2007;9:19–30.

Warner J, editor. Multi-stakeholder platforms for integrated water management. Aldershot: Ashgate; 2007. 281 pp.

Watson N. Integrated river basin management: a case for collaboration. Int J River Basin Manag 2004;2:1-15.

Watson N. Collaborative capital: a key to the successful practice of integrated water resources management. In: Warner J, editor. Multi-stakeholder platforms for integrated water management. Ashgate: Aldershot; 2007. p. 31–48.

Waterton C, Norton L, Morris J. Understanding Loweswater: interdisciplinary research in practice. J Agric Econ 2006;57:277–93.

Watson N, Deeming H, Treffny, R. Beyond Bureaucracy? Assessing institutional change in the governance of water in England. Water Altern 2009;2:448–60.

Wondolleck JM, Yafee SL. Making collaboration work: lessons from innovation in natural resource management. Washington DC: Island Press; 2000. 277 pp.

Wynne B. Uncertainty and environmental learning: re-conceiving science and policy in the preventative paradigm. Glob Environ Change 1992;2:111–27.